Strange and charm meson masses from twisted mass lattice QCD

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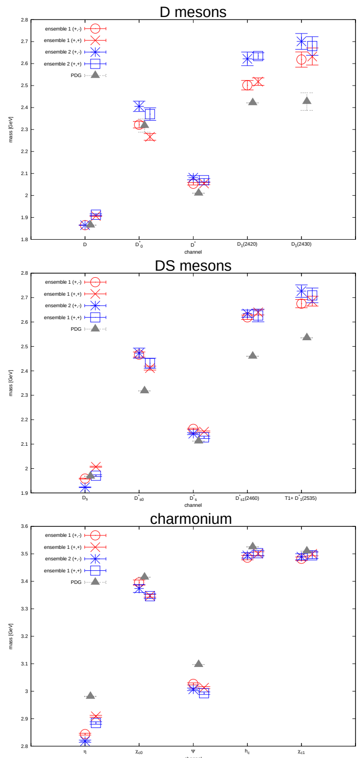

Figure 1: Calculated D, D_s meson and charmonium masses at the two ensembles. Grey data points represent experimental results.

Introduction

The recent discoveries of new open charm mesons at the BaBar, Belle and CLEO has attracted much interest both in the theoretical and experimental community, since the new states do not fit well into the quark model predictions for heavy-light systems in contrast to the previously known D states. Lattice QCD gives us a non-perturbative method to calculate numerically the spectrum of bound states consisting of quarks, antiquarks and gluons from first principles. We intend to extract part of the meson spectrum with focus to highly excited states, i.e. states with quantum numbers ($J^{PC} = 1^{-+}, 2^{+-}, ...$). For this we use $2+1+1$ lattice gauge configurations produced by the $ETMC$ (European Twisted Mass Collaboration).

Setup

Currently we have performed computations on $\approx$ 700 gauge field configurations from two ensembles.

For both the valence strange and charm quarks we use degenerate twisted mass doublets, i.e. a different discretization as for the corresponding sea quarks. We do this, to avoid mixing of strange and charm quarks [1], which inevitably takes place in a unitary setup, and which is particularly problematic for hadrons containing charm quarks.

For the computation of the corresponding correlation matrices we use spin diluted timeslice sources in combination with the “one-end trick”. Meson masses are then determined from plateaux values of corresponding effective masses, which we obtain by “diagonalizing” the correlation matrices by solving generalized eigenvalue problems. For more details see [2] and references within.

Results

In fig.[1] we show results for our first two ensembles which differ in the pion mass. The red points correspond to the lower, more physical pion mass. At finite lattice spacing in the twisted mass formulation we get two numbers for every meson mass. These differences vanish in the continuum limes. From the shown differences we expect the discretization effects to be smaller than 5%.

Future plans include computations on further ensembles with various light quark masses and even finer lattice spacings. This will enable us, to extrapolate our theoretical results to physical quark masses and to the continuum, which in turn allows a direct meaningful comparison with experimental results as e.g. expected from the PANDA experiment at FAIR.

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References

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